
**Non-parallel steel wire and cords for
tyre reinforcement**

Fils d'acier et cordes non parallèles pour le renfort de pneumatiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 17, *Steel wire rod and wire products*.

This second edition cancels and replaces the first edition (ISO 17832:2009), which has been technically revised.

The following changes have been made:

- tensile strength for UT, ST and NT constructions has been updated;
- HI construction has been added;
- the tolerance for lay length has been narrowed from “±10 %” to “±5 %”;
- the tolerance of residual torsion for HE construction has been narrowed from ±4 torsion/6 m to ±3 torsion/6 m;
- the tolerance for spool length has been narrowed;
- the weld breaking load for HT, ST and UT constructions has been increased.

Non-parallel steel wire and cords for tyre reinforcement

1 Scope

This document specifies the definition and requirements of non-parallel steel wire and cords for tyre reinforcement.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3951-1, *Sampling procedures for inspection by variables — Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 3951-2, *Sampling procedures for inspection by variables — Part 2: General specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection of independent quality characteristics*

ISO 3951-3, *Sampling procedures for inspection by variables — Part 3: Double sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3951-5, *Sampling procedures for inspection by variables — Part 5: Sequential sampling plans indexed by acceptance quality limit (AQL) for inspection by variables (known standard deviation)*

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3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

filament

metal fibre with a metallic alloy coating used as an individual element in a *strand* (3.2) or *cord* (3.3)

3.2

strand

group of *filaments* (3.1) combined together to form a unit product for further processing

3.3

cord

formed structure composed of two or more *filaments* (3.1) when used as an end product, or a combination of *strands* (3.2) or filaments and strands

3.3.1

single-strand cord

cord (3.3) formed by twisting two or more *filaments* (3.1) together

3.3.2

M+N type cord

cord (3.3) formed by twisting a number of non-concentric *filaments* (3.1) around a number of parallel filaments

Note 1 to entry: The cross-section is not round and varies along the length.

3.3.3

layer cord

cord (3.3) formed by adding layers around a core

Note 1 to entry: The layers can be filaments or strands.

3.3.4

multi-strand cord

cord (3.3) formed by twisting two or more *strands* (3.2) together

3.4

wrap

filament (3.1) wound helically around a steel *cord* (3.1)

3.5

direction of lay

helical disposition of the components of a *strand* (3.2) or cord

Note 1 to entry: The strand or cord has an “S” or left-hand lay, when held vertically, if the spirals around the central axis of the strand or cord conform in direction of slope to the central portion of the letter “S”.

Note 2 to entry: The strand or cord has a “Z” or right-hand lay if the spirals conform in direction of slope to the central portion of slope of the letter “Z”.

3.6

length of lay

axial distance required to make a 360° revolution of any element in a *strand* (3.2) or in a *cord* (3.3)

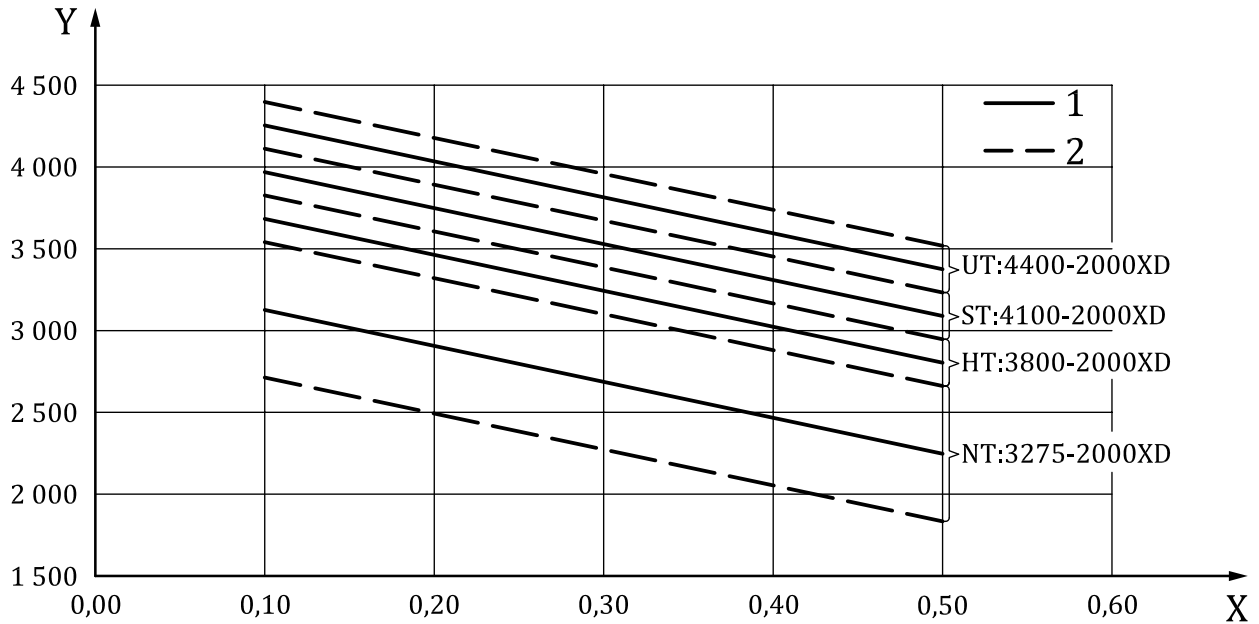
Note 1 to entry: The length of lay is expressed in millimetres.

4 Classification

4.1 Classification based on tensile strength

Steel cord is supplied in levels of tensile strength (see [Figure 1](#)), designated as follows:

- NT: normal standard (or regular) tensile strength cord;
- HT: high tensile strength cord;
- ST: super tensile strength cord;
- UT: ultra tensile strength cord.



Key

- X filament diameter, mm
- Y filament tensile strength, MPa
- 1 solid line indicates target value
- 2 dashed line indicates tolerance range

NOTE The target value is determined by agreement between the manufacturer and the purchaser.

Figure 1 — Tensile strength levels

Figure 1 gives the tensile strength levels of wet-drawn filaments. The cord breaking load is calculated from the filament number, lay length and cabling loss. For example, cord construction 2x0,30ST 14/S is calculated by Formula (1):

$$F = n \times (f \times \cos \alpha) \times (1 - C) \tag{1}$$

where

- F is the breaking load of cord construction 2x0,30ST 14/S, in mega pascals;
- f is the breaking load of 0,30ST, in mega pascals;
- α is the cabling angle, in degrees;
- n is the number of filament;
- C is the cabling loss on tensile strength (e.g. 4 %).

4.2 Classification based on cord structure

The main classification based on cord structure is categorized by the following four structures:

- single-strand cords;
- M+N type cords;
- layer cords;
- multi-strand cords.

4.3 Classification based on cord type

The main classification based on cord type is categorized by the following four types:

- HE: high-elongation cord;
- OC: open cord;
- CC: compact cord;
- WC: wavy cord, a cord with filaments preformed in 2 or 3 dimensional wavy shape in order to improve rubber penetration;
- HI: high impact cord.

Another detailed classification may be used if there is mutual agreement between the manufacturer and the purchaser.

5 Designation and ordering

A tyre cord construction is normally defined by

- cord structure,
- cord tensile strength,
- cord type,
- length and direction of lay, and
- coating type.

5.1 Cord structure

The description of the cord structure follows the sequence of manufacture of the cord, i.e. starting with the innermost strand or wire and moving outwards.

The full description of the cord structure is given by the following formulas:

$$(N \times X) \times D + (N \times X) \times D + (N \times X) \times D + D, \text{ or}$$

$$(N \times X) \times D / (N \times X) \times D / (N \times X) \times D + D \text{ for compact cords, and}$$

$$(N \times N) \times D + D$$

where

N is the number of strands;

X is the number of filaments;

D is the nominal diameter of wires, expressed in millimetres.

EXAMPLE 1 $(1 \times 3) \times 0,22 + (1 \times 9) \times 0,22 + (1 \times 15) \times 0,22 + 0,15$.

When N or F equals 1, they should not be included.

EXAMPLE 2 $3 \times 0,22 + 9 \times 0,22 + 15 \times 0,22 + 0,15$.

If the diameter D is the same for two or more parts in sequence, it shall only be stated at the end of the sequence.

The diameter of the spiral wrap shall always be stated separately.

EXAMPLE 3 $3 + 9 + 15 \times 0,22 + 0,15$.

When the innermost strand or wire is identical to the adjacent strand or wires, the formula may be simplified by stating only the sum of the identical components and brackets need not be used.

EXAMPLE 4 $0,22 + 6 \times 0,22 + 6 \times (0,22 + 6 \times 0,22)$ becomes $7 \times 7 \times 0,22$.

5.2 Cord tensile strength

There are four levels of tensile strength: NT, HT, ST and UT as defined in [4.1](#). The tensile class of the spiral wrap is not governed by the tensile class levels.

5.3 Cord type

See [4.3](#)

5.4 Length and direction of lay

The sequence or order in the designation follows the sequence of manufacturing, i.e. starting with the innermost strand and moving outwards.

EXAMPLE 1

$3 + 9 + 15 \times 0,175 + 0,15$

5/10/16/3.5 SSZS

5 S: lay length and direction of the strand $3 \times 0,175$

10 S: lay length and direction of the strand $+ 9 \times 0,175$

16 Z: lay length and direction of the strand $+ 15 \times 0,175$

3,5 S: lay length and direction of the spiral wrap

EXAMPLE 2

$7 \times (3 + 9 + 15 \times 0,175) + 0,20$

(5/10/16)/(5/10/16)/38/5 SSS/ZZZ/S/Z

5 S: lay length and direction of the innermost strand $3 \times 0,175$

10 S: lay length and direction of the innermost strand $+ 9 \times 0,175$

16 S: lay length and direction of the innermost strand $+ 15 \times 0,175$

5 Z: lay length and direction of the adjacent strand $3 \times 0,175$

10 Z: lay length and direction of the adjacent strand $+ 9 \times 0,175$

16 Z: lay length and direction of the adjacent strand $+ 15 \times 0,175$

38 S: lay length and direction of the cable

5 Z: lay length and direction of the spiral wrap

5.5 Coating type

There are two classic types of brass coating: high-copper coating and normal copper coating, as listed in [Table 2](#). More advanced metallic alloy coatings such as Cu-Zn-Co are possible.

6 Requirements

6.1 General

Specified tests are mainly conducted in accordance with internationally agreed methods for steel tyre cords, such as ASTM D2229-10, ASTM D2969-04, BISFA, JIS G 3510, etc.

6.2 Dimensions, mass and tolerances

6.2.1 Diameter of cord

The diameter of the circumscribed circle of cord, in millimetres, and detailed requirements are listed in [Table 5](#).

6.2.2 Linear density

The linear density, i.e. the mass of a 1 m length of cord, in grams per metre (g/m), and detailed requirements are listed in [Table 5](#).

6.2.3 Tolerances

The tolerance of the cord length shall conform to [Table 1](#).

Tolerance of filament diameter: $\pm 10 \mu\text{m}$.

Tolerance of lay length: $\pm 5 \%$.

Tolerance of residual torsion of cord: ± 3 torsions/6 m in general.

Table 1 — The tolerance of the cord length

Cord length, <i>L</i> m	Tolerance ^a %
$L \leq 2\,000$	$\pm 0,75 \%$
$>2\,000$ approximately $8\,000$	$\pm 0,50 \%$
$>8\,000$	$\pm 0,25 \%$
^a With a minimum of ± 10 m.	

6.3 Welds and splices

Continuous lengths shall be supplied as follows:

Cord may be welded and shall withstand a minimum load as follows:

- for NT,HT cord: 40 % of the minimum breaking load of the cord;
- for ST,UT cord and off-the-road cords: 35 % of the minimum breaking load of the cord.

An additional bending test is needed for the control of the welds.

In the case of layer cords, splicing or a simple knot filament connection can be used in lieu of welds, except in the outer-most layer.